



JRA Detectors

Gaseous Scintillation Proportional Counters

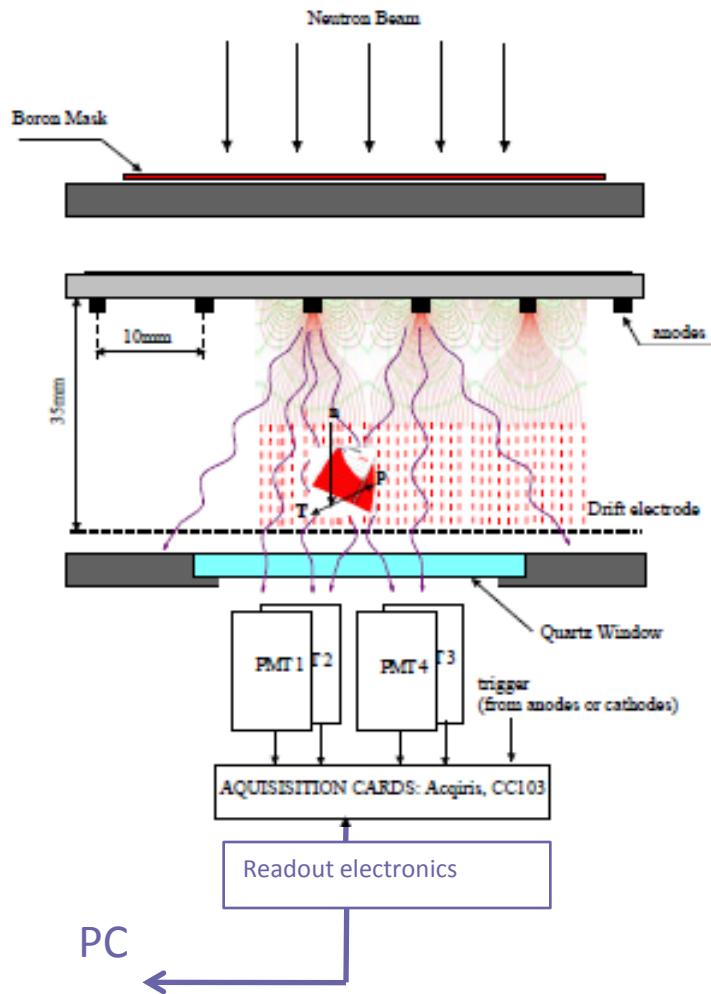
CNR, FZJ, ILL, LIPC, STFC, TUM

Status Report

Fiumicino, November 9, 2011

- Development of new detector technologies based on Gaseous Scintillation Proportional Counters (GSPC)
 towards a fast, high resolution detector

GSPC components



Outline of Tasks

W22.2

- Study photon yield as function of gas mixtures
- MC Simulation of GSPC Performance
- Investigation of micro pattern devices for a GSPC device
- Design of small prototypes for light readout studies
- Construction of demonstrator detector

W22.3

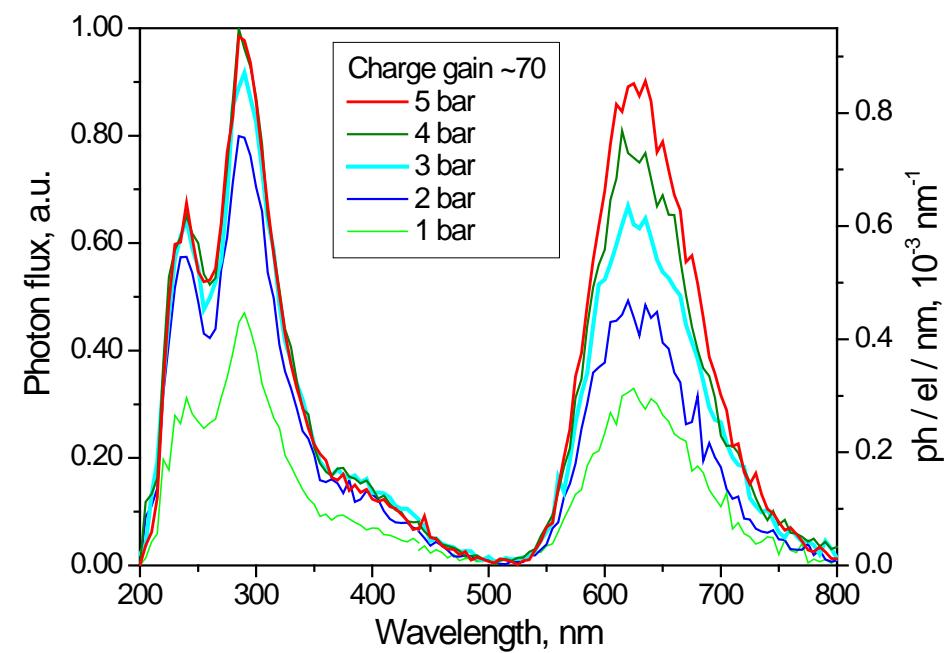
- Explore options of light readout devices
- Develop and provide appropriate readout electronics
- Evaluate appropriate signal analysis and processing schemes

LIPC, ILL

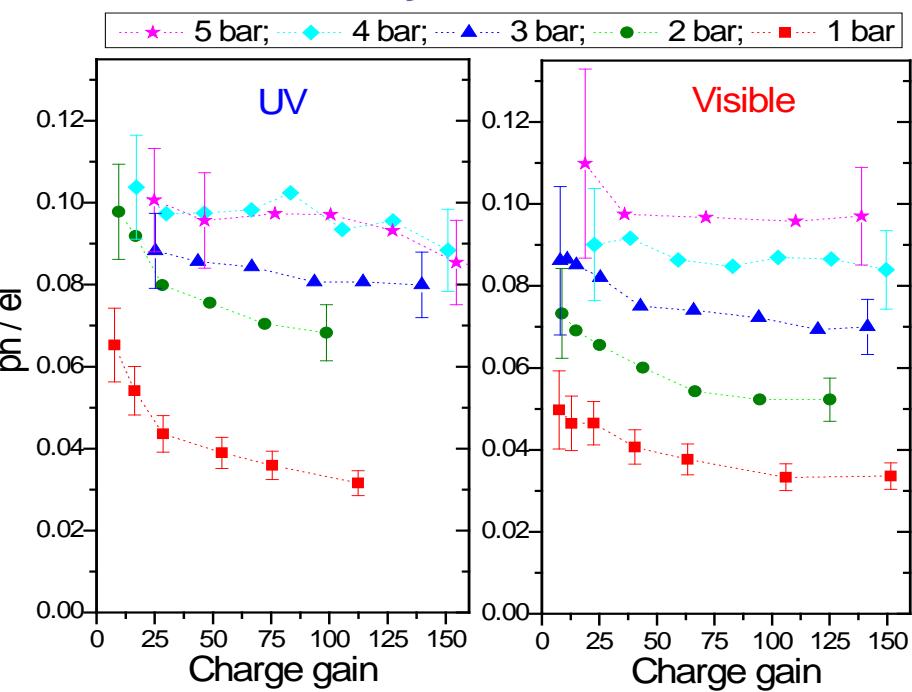
Photon yield, decay time and spectral emission of primary & secondary light by CF_4 in the pressure range $0.5 \text{ bar} < p < 5 \text{ bar}$.

Influence of gas impurities on the scintillation process and effectiveness of gas purifiers

Emission spectra of secondary light in CF_4



Photon yield in CF_4



→ $10^5 - 10^6$ photons /n

LIPC

ANTS : MC Software for simulation of Anger-camera neutron detectors

Modules:

“Mechanical”:

PMT configuration

PMT to microstrip distance

Output window thickness

“Optical”

Refraction and absorption coefficients

PMT detection efficiency

PMT area and angular sensitivity

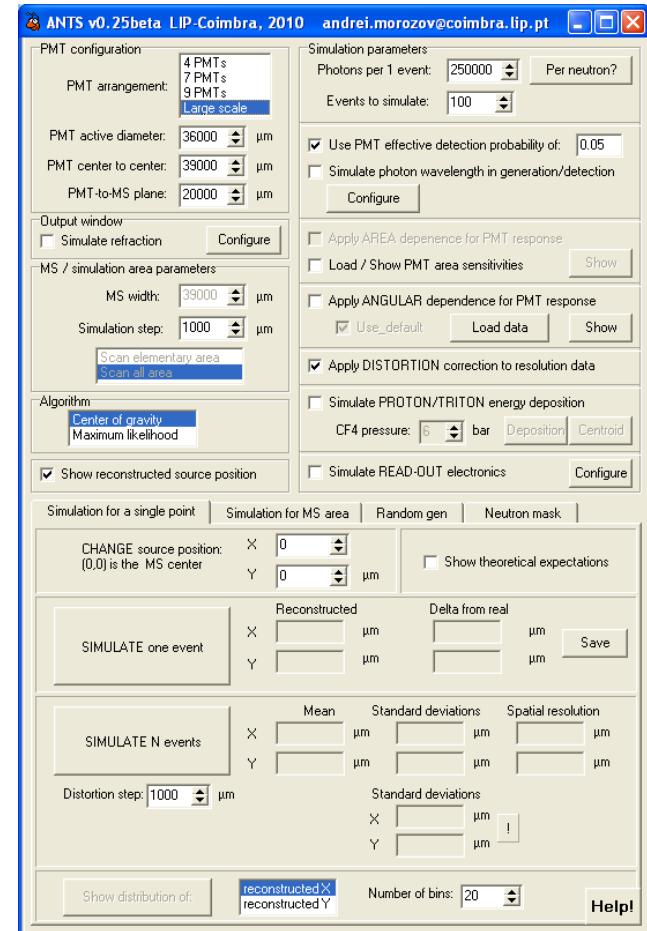
“Physical”

Photons/electron ratio and the gas gain

Emission spectrum of the secondary scintillation

“Reconstruction”

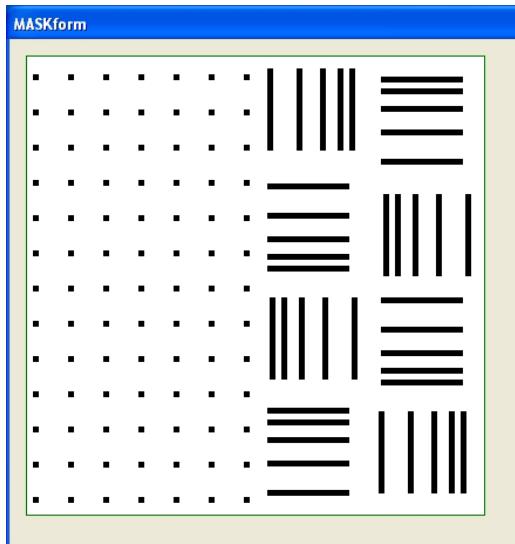
e.g. Centre-of-Gravity, max. likelihood



■ ANTS : MC Software for simulation of Anger-camera neutron detectors

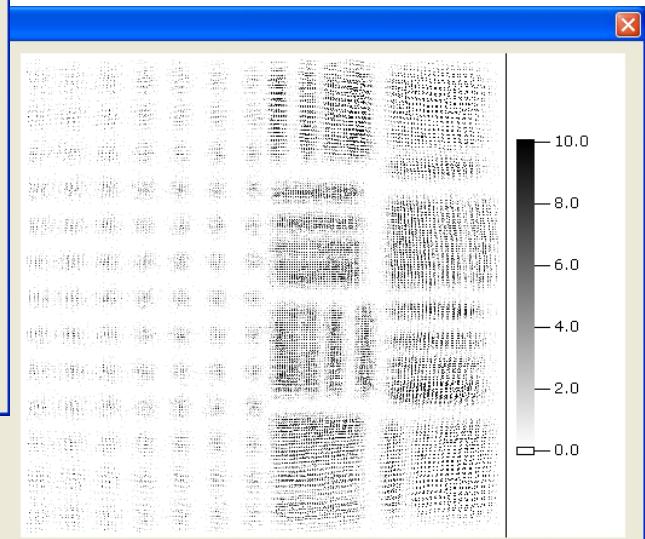
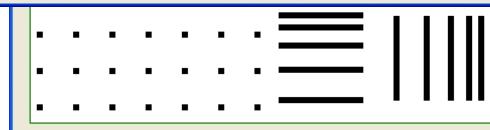
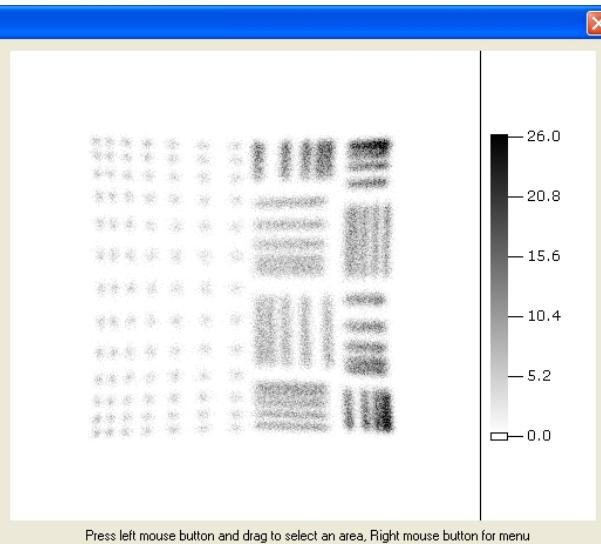
Allows to study the influence of specific physical parameters and the prediction of the detector performance: ideal tool for detector design

Cd-Mask on GSPC



4 PMTs, CoG, no correction

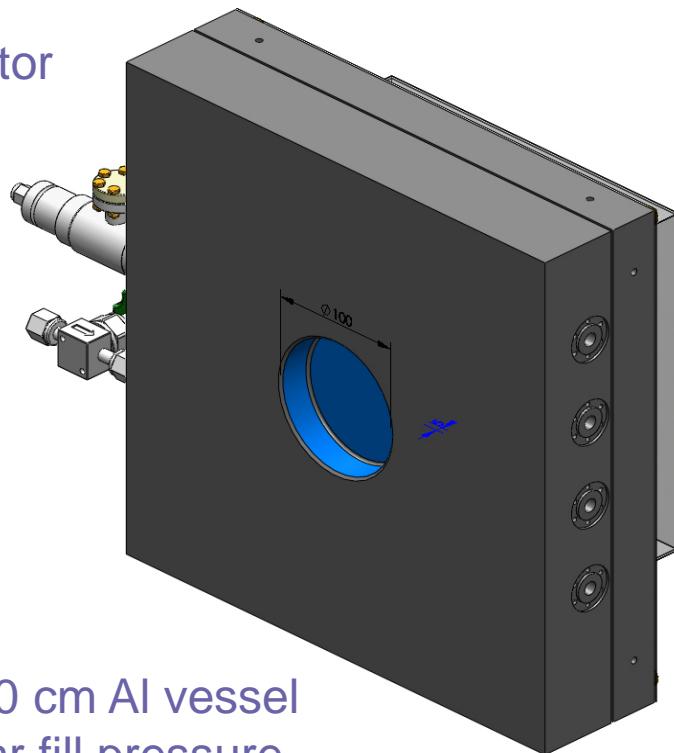
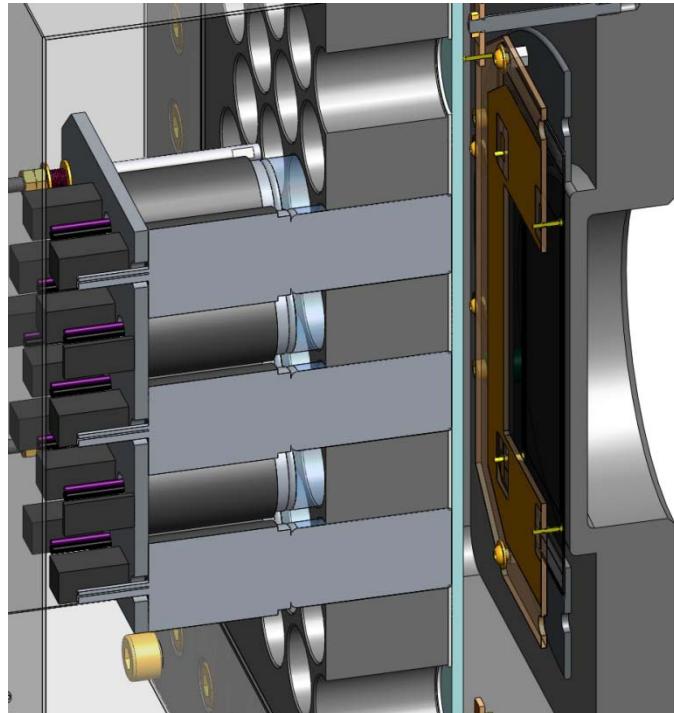
Detector response



4 PMTs, CoG, with the correction

■ ILL

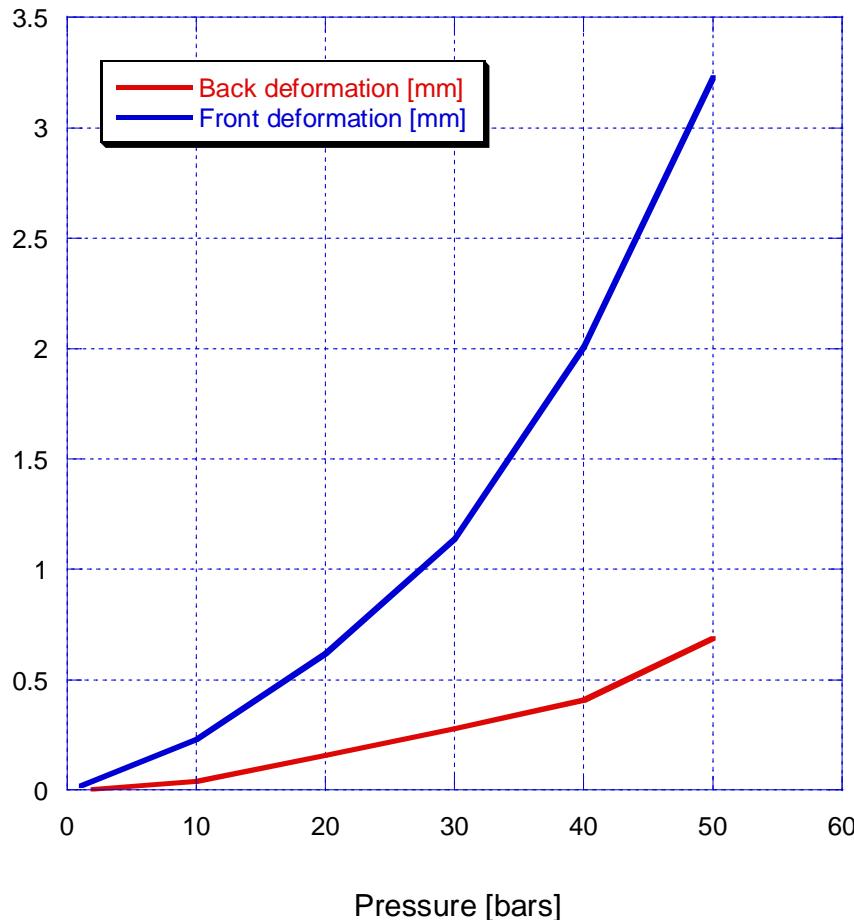
Design GSPC 19 - a large area prototype detector



- 40x40 cm Al vessel
- 10 bar fill pressure
- Entrance Al window (5 mm)
- MSGC500 plate (8 cm x 8 cm)
- 3.3 mm Borofloat glass window
- ITO drift electrode
- 20 Hamamatsu R5070A PMTs

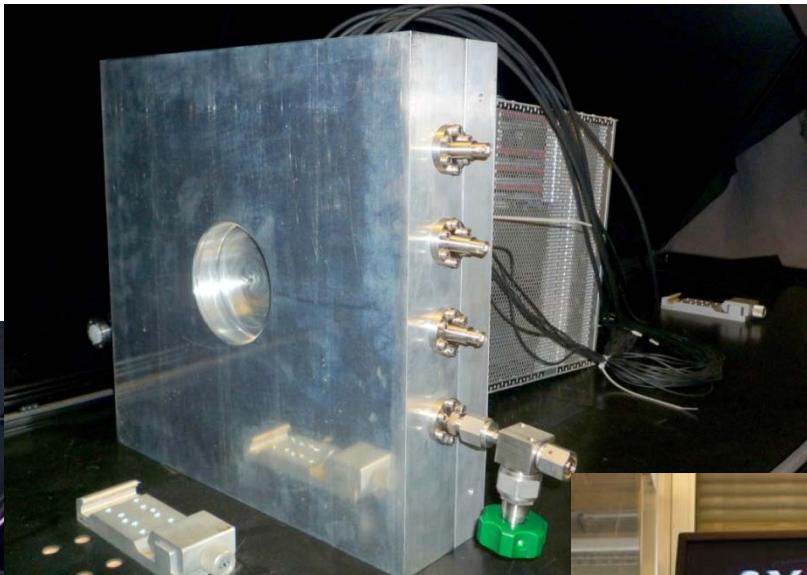
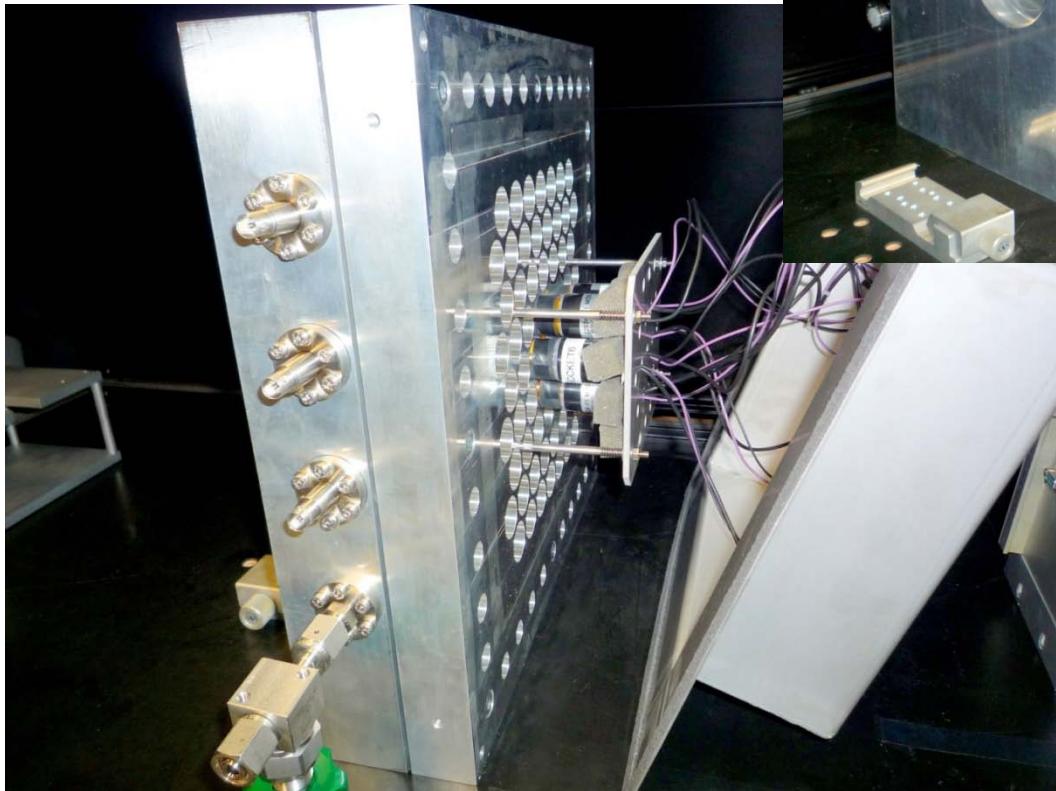
Pressure test

50 bar with water, 3,3 mm window



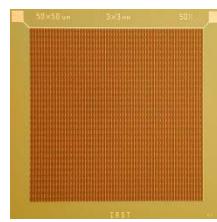
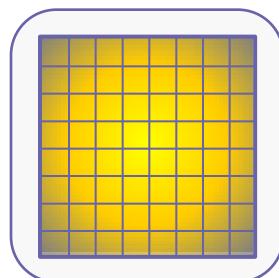
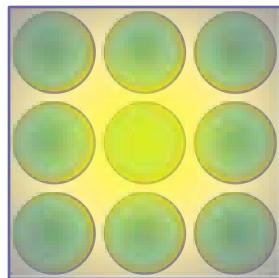
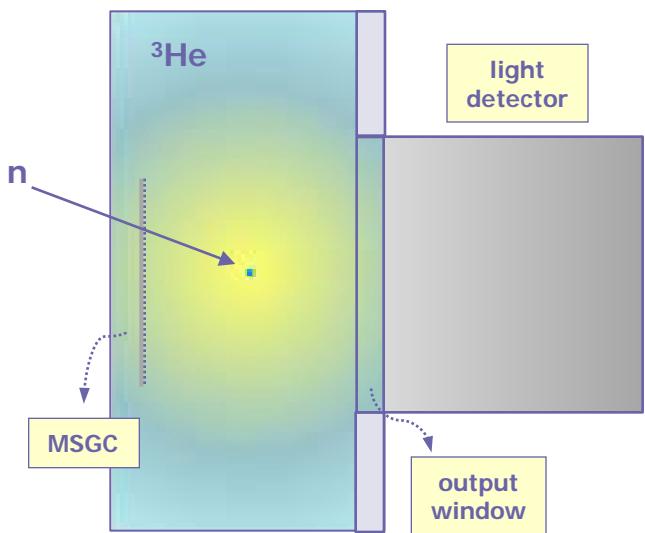
GSPC 19 @ ILL

Test with 7 PMTs +ZnS scintillator
Ready for mounting of MSGC



Options for light readout devices

Gaseous Scintillation Proportional Counter



Anger Camera

- Array of individual PMTs
- Simultaneous readout of all PMT signals
- Position reconstruction via software algorithms

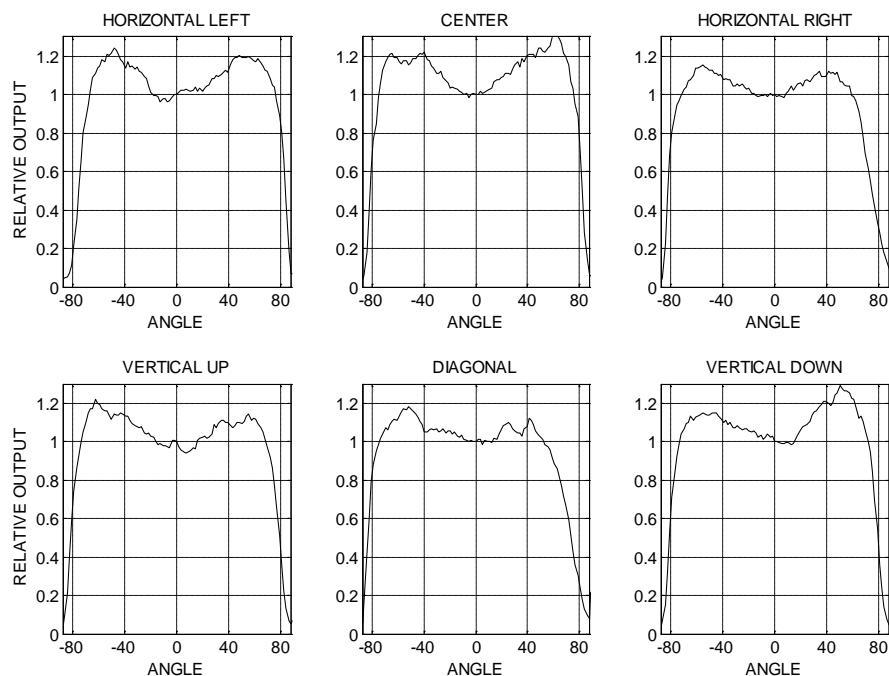
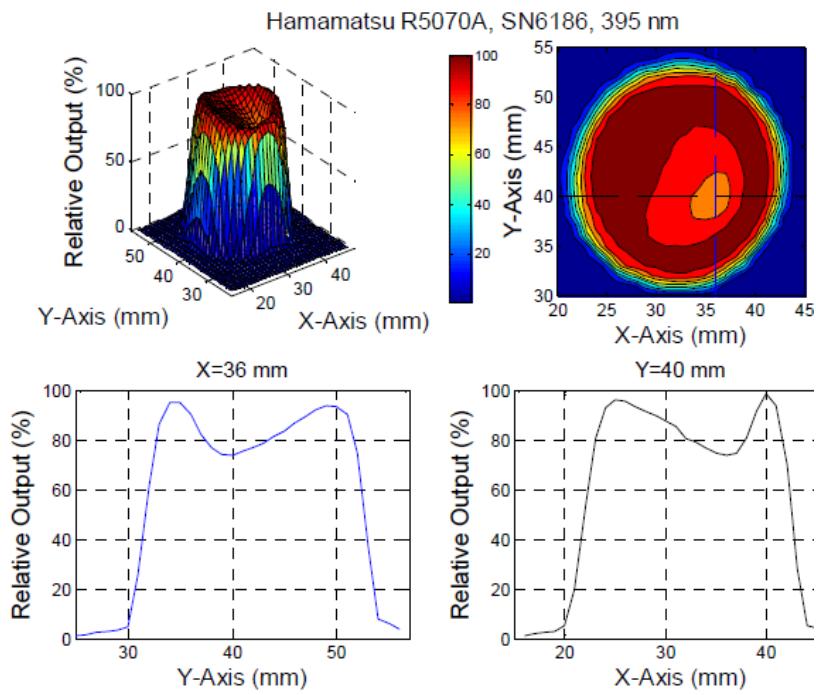
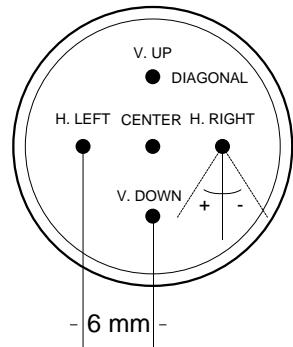
Position Sensitive PMT

- One PMT with mesh dynode structure
- Anode wires in X/Y
- Readout by resistor chain
- Position reconstruction via pulse division method

Si PMTs ?

■ LIPC, FZJ

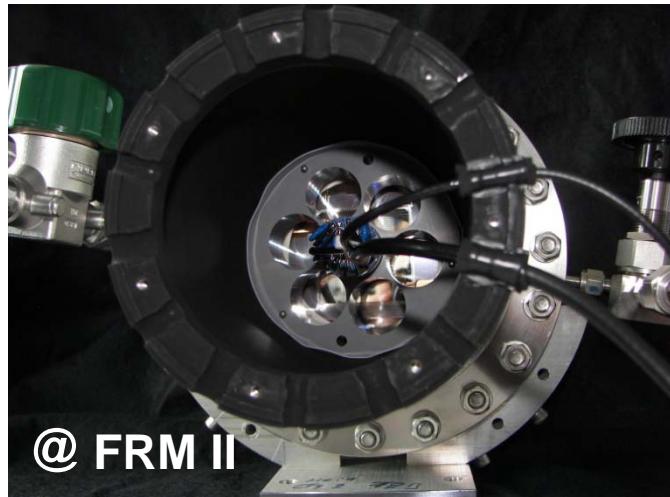
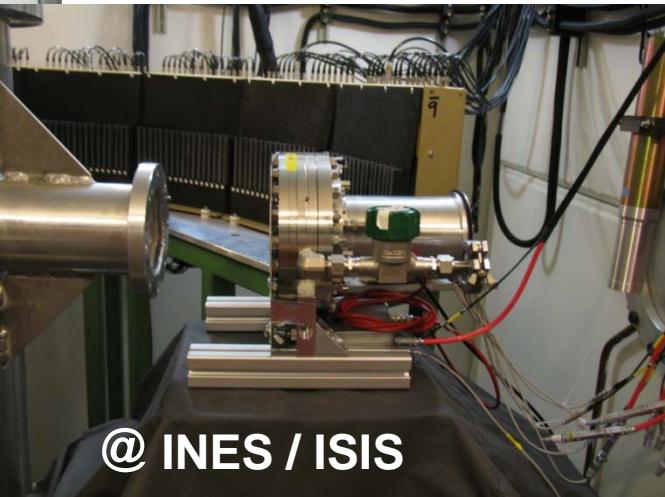
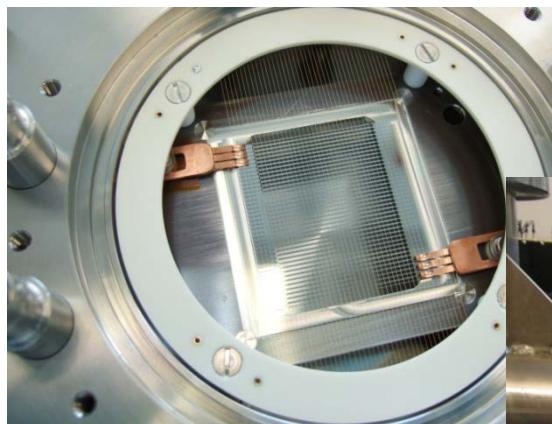
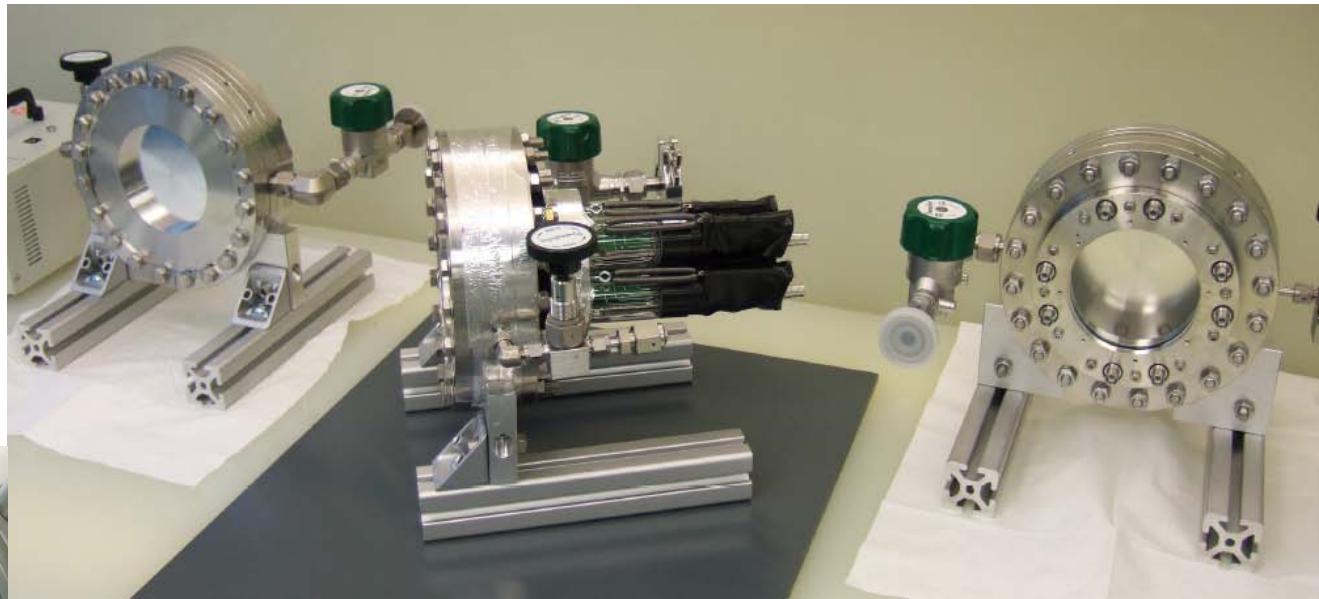
Precise determination of gain variation, spatial uniformity, wavelength and angular dependence of the sensitivity of the photocathode of a Hamamatsu R5070 PMT



■ TUM

Small size GSPC
to study different
light detecting
devices

Identical devices
delivered to ISIS & FZJ

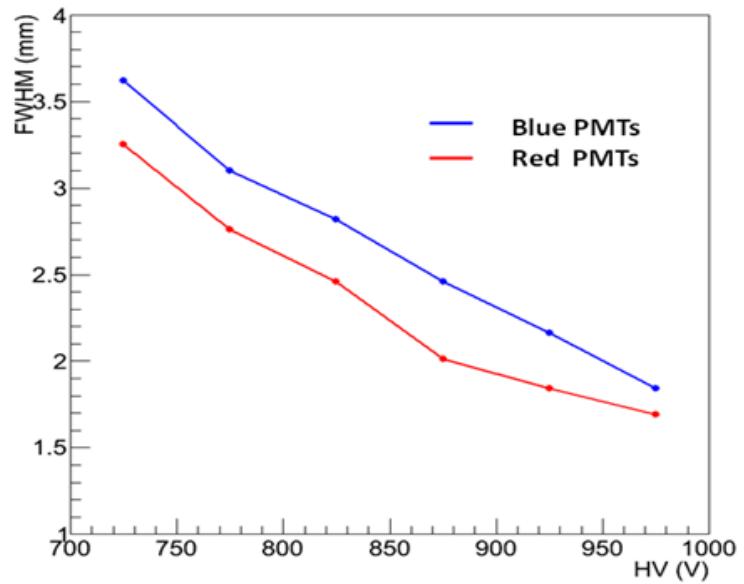
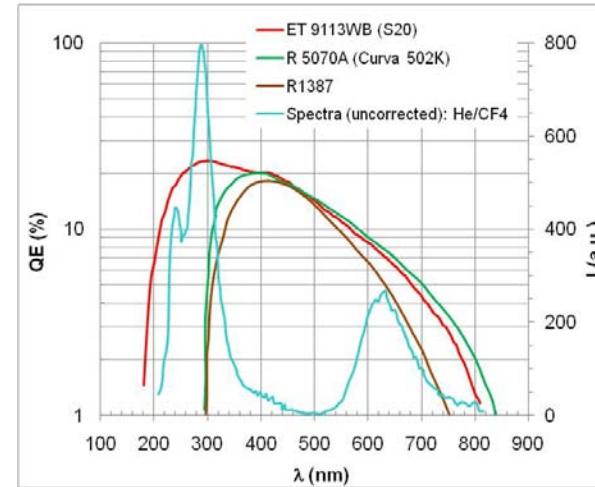
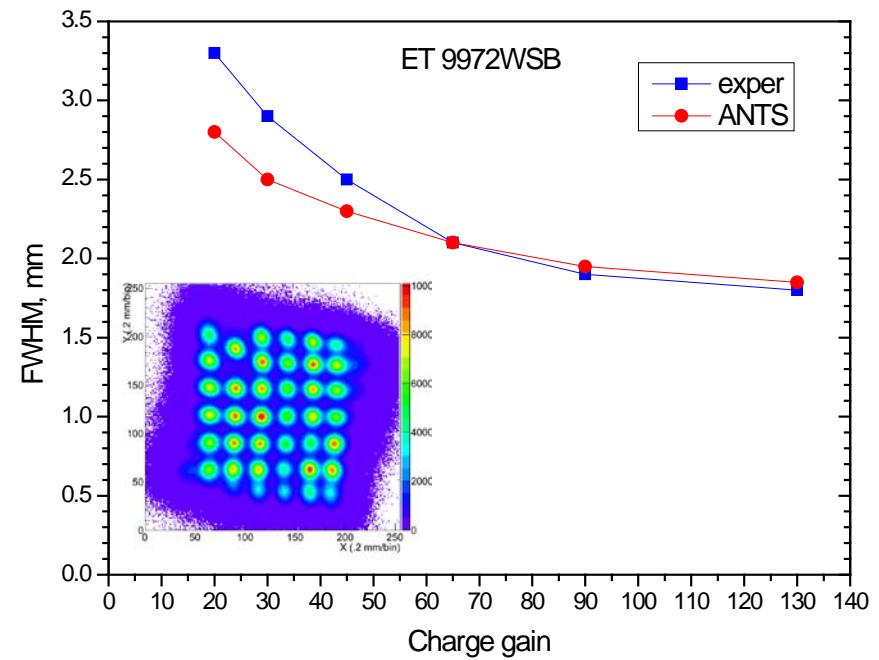


■ STFC

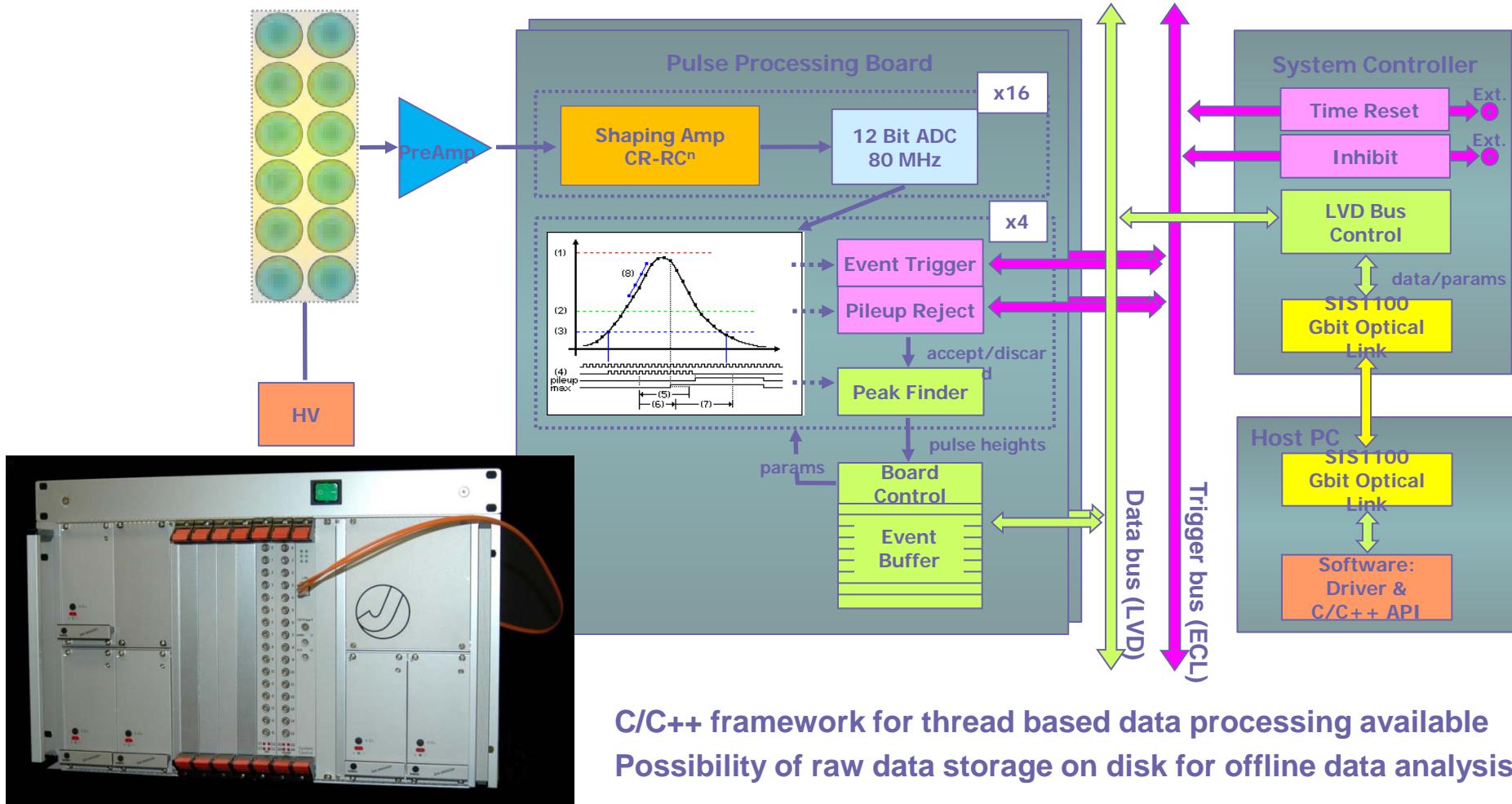
Determine the relative effectiveness of:

Borosilicate glass window bialkali blue PMTs
versus UV window S20 red PMTs

Measured position resolution



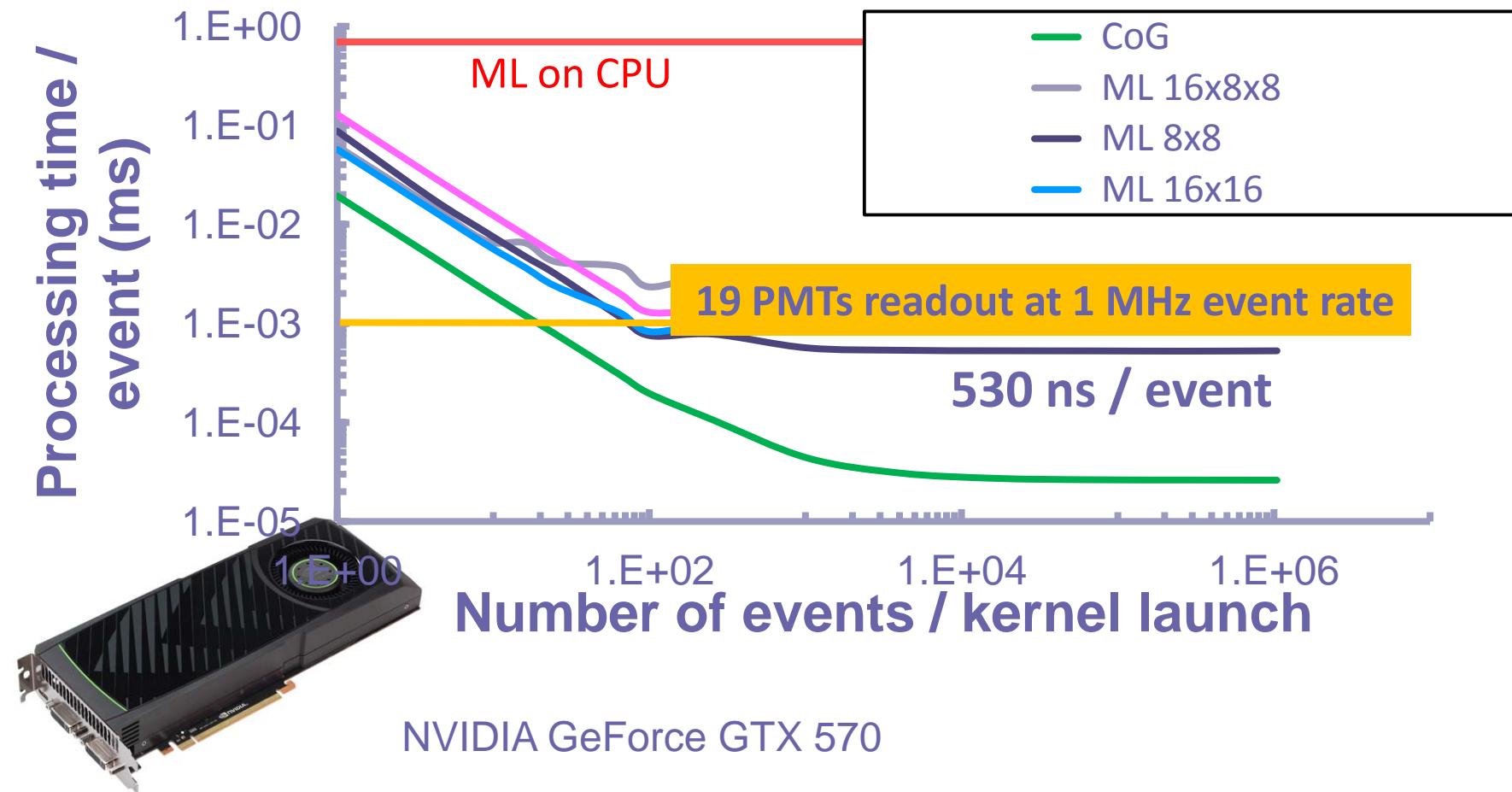
Development of Anger Camera Readout Electronics



C/C++ framework for thread based data processing available
Possibility of raw data storage on disk for offline data analysis

TUM

Online position determination with maximum likelihood method implemented on a fast Graphics Processing unit



■ STFC

Embedded neural network processing

Neural Network embedded in an FPGA

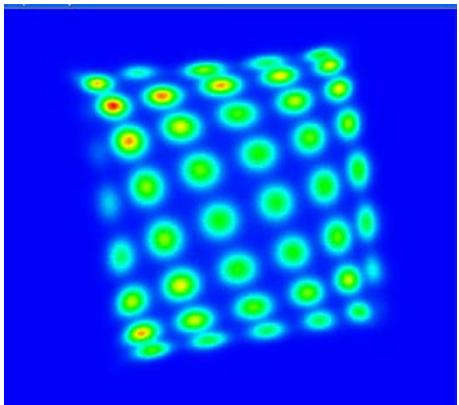
Terasic Altera DE3 Development System

4 IO connectors: 3 for ADC boards
1 for communication

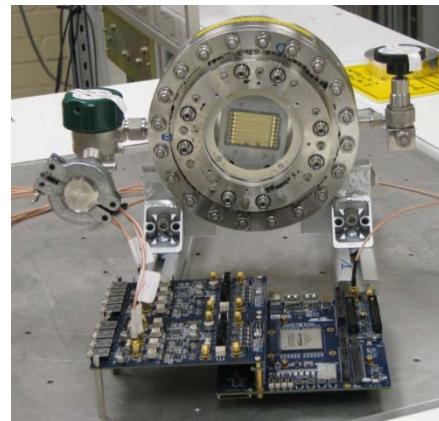
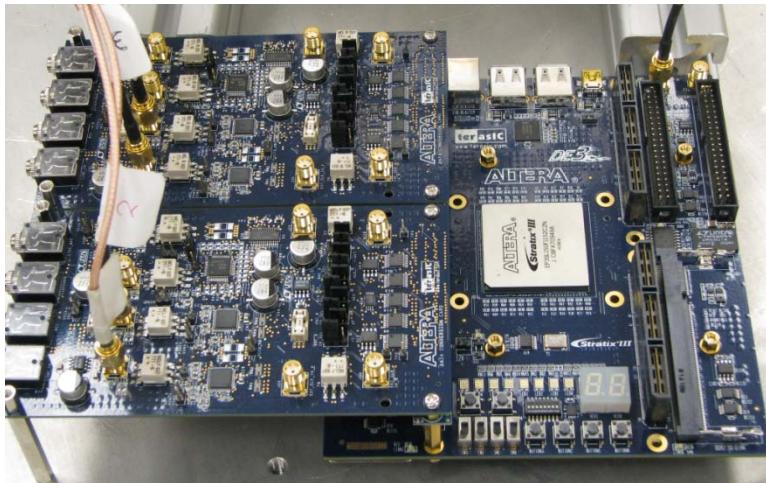
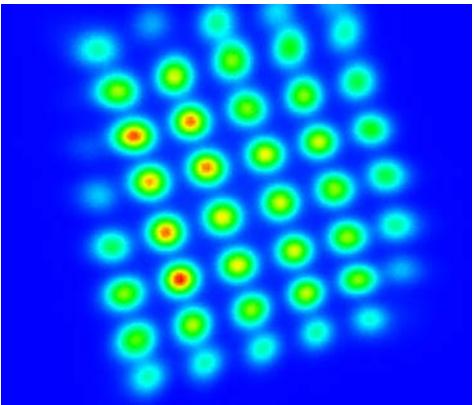
Terasic AD/DA Data Conversion Card

Two 14-bit ADCs, 150MSPS

CoG



NN





Summary

- MC Simulation is a powerful tool to optimize the detector design
- Important physical parameters measured and their influence on detector performance understood
- Large area Demonstrator under construction
- Two potential readout and signal processing schemes identified and under realization